Train Noise Mitigation Plan

Submitted to:

City of DeKalb, Illinois

Prepared by

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EXHIBIT
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Executive Summary

Hanson-Wilson, Incorporated (HWI) was retained by the City of DeKalb to investigate the seven at-grade crossings of the Union Pacific Railroad and to develop a plan for the mitigation of train noise at each of the crossings. The objective of the plan is to determine the most cost effective safety enhancement option at each grade crossing in DeKalb, Illinois that results in the successful mitigation of train noise without compromising public safety or significantly impacting traffic flow.

The investigation determined that Automated Train Horns are the most cost effective safety enhancement option at the 1st Street, Route 23 & 38 intersection, 6th Street, 7th Street and 10th Street grade crossings that will permit the elimination of the locomotive horn. Automated Train Horns are the optimal choice because they have the least cost per total weighted benefit unit as discussed in the Safety Enhancement Option Evaluation Methodology Section and as deduced by the respective evaluation matrices for each crossing. At the 2nd and 3rd Street grade crossings, it was determined that no further improvements are necessary to silence the train horn at those crossings.

The approximate initial capital cost for the installation of ATHs at the 1st Street, Route 23 & 38 Intersection, 6th Street, 7th Street and 10th Street grade crossings is estimated at $600,000. The initial capital cost includes design, equipment, material, labor and 20% contingencies. The approximate ongoing maintenance cost for ATHs at all of these grade crossings is estimated at $6,000 per year. The estimated capitalized cost of the ongoing maintenance for ATHs at all of these crossings, which is equivalent to the present value of future maintenance disbursements, is $90,000. The approximate cost for periodic ATH equipment replacement every 20 years is $66,000 per crossing. The estimated capitalized cost of periodic replacement of ATH equipment at all these crossings, which is equivalent to the present value of future disbursements for equipment replacement including labor, is $138,000. The total estimated capitalized cost for the automated train horns is $828,000 and includes the up-front cost for the installations ($600,000), the present value of future maintenance disbursements ($90,000) and the present value of future disbursements for equipment replacement ($138,000).

It is recommended the City of DeKalb adopt this plan for mitigation of train noise. It is further recommended the City of DeKalb meet with representatives from the Union Pacific Railroad, the Illinois Commerce Commission and Illinois Department of Transportation to present the adopted plan and to develop an implementation strategy for installation of ATHs at the 1st Street, Route 23 & 38 intersection, 6th Street, 7th Street and 10th Street grade crossings which, in combination with existing full closure gates at 2nd and 3rd Streets, will allow the silencing of the locomotive horn as trains travel through DeKalb.

Introduction

Locomotive engineers are required by law and their railroad's code of operating rules and regulations to sound the train horn ¼ mile in advance of a grade crossing. They are also required to continue to sound the horn until the train arrives at the crossing. If the train horn is to be an effective warning device for the motorist, it must provide a sound level capable of initiating a response from the driver when the train is approaching the crossing. Unfortunately, the sound level required to achieve that response and the location of the train relative to the crossing creates a significant noise that can impact the quality of life in a community. Federal regulations require the train horn to be at least 96 decibels (dBA) 100 feet in front of the train in its direction of travel (CFR 229.129, 1992). The train horn is also characterized by a broadband signal that can mask sound over a wide frequency range thus interfering with conversations. The frequency range for the most common train horns is between 250 and 8,000 Hz with the greatest intensity in the range from 500 to 2,500 Hz (Keller and Rickley, 1993). Speech interference can occur when noise level rises above 70 decibels between the frequency range of 600 to 4800 Hz (Bailey, 1989). The following Table shows how the signal intensity decreases as distance from the grade crossing increases.

Relationship between Distance of Listener from Train and Signal Intensity	
Distance (feet)	Signal Intensity dB (A)
100	96
200	90
400	84
800	78
1600	72
3200	66

Speech interference can thus occur up to 1,600 feet from the track when the train horn is sounding.

The Union Pacific Railroad's double track mainline, the Geneva Subdivision, crosses eight streets at-grade in the downtown area of the City of DeKalb with approximately 80 trains per day. The maximum timetable speed is 70 MPH but the average train speed may be approximated at 40 MPH. There are 3,749 feet between the 10th Street crossing at Milepost 58.06 and the 1st Street crossing at Milepost 58.76. Since all the at-grade crossings in DeKalb are less than ¼ of a mile from an adjacent crossing, the noise from the horn of a train operating at an average speed of 40 MPH is continuous for approximately 1 minute, 26 seconds from train arrival to train departure. Eighty trains per day at an average speed of 40 MPH equates to approximately one hour and fifty-five minutes of cumulative train horn noise in DeKalb every 24 hours. It is noted that the Occupational Safety and Health Administration (OSHA) requires employers to develop and implement a noise monitoring program when noise levels exceed 100 decibels for a 2-hour period or 80 decibels for a 8-hour period.

The Federal Railroad Administration (FRA) currently has sanctioned the installation of several safety enhancement options that allow the train engineer to desist from sounding the conventional horn in the locomotive. The FRA sanctioned safety enhancement options that allow the silencing of the locomotive horn entirely include the following:

- Median barriers or channelization devices in combination with two-quadrant gates,
- Four-quadrant gates,
- Video enforcement in combination with two-quadrant gates,
- Crossing closure (either permanent or during night hours), and
- Paired one-way streets with full closure gates.

The recommendations developed in the plan involved an evaluation of the various FRA sanctioned safety enhancement alternatives excluding the crossing closure option and the paired one-way streets with full closure gates option. The crossing closure option and the paired one-way streets with full closure gates option were eliminated from the investigation because they were not considered to be viable options at any of the crossings in DeKalb except at the 2nd and 3rd Streets grade crossings. The 2nd and 3rd Streets grade crossings already are paired one-way streets with full closure gates and thus qualify now for elimination of the locomotive horn.

Automated Train Horns (ATHs) were also included in this investigation. Automated Train Horns (ATHs) consist of a stationary alarm system, directed at vehicular and pedestrian traffic, that is activated by the railroad crossing warning system. Automated Train Horns greatly reduce the amount of train noise in populated areas near rail corridors. Although Automated Train Horns, sometimes called wayside horns, have yet to be approved by the FRA as a safety enhancement option that will permit the elimination of the locomotive horn, they are currently being formally evaluated by the FRA in Mundelein, Illinois. From preliminary feedback and available information, it appears the evaluation of that test installation may allow ATHs to be accepted by the FRA as an approved safety enhancement option that will permit the elimination of the locomotive horn.

Safety Enhancement Option Discussion

General

Median barriers or channelization devices in combination with two-quadrant gates, four quadrant gates, video enforcement in combination with two-quadrant gates, crossing closure (either permanent or during night hours), and paired one-way streets with full closure gates are currently approved by the FRA to allow the silencing of the locomotive horn entirely. Automated Train Horns (ATHs) or wayside directional horns as they are also called will not eliminate train noise but will replace the locomotive horn with a stationary local alarm that will focus the noise only toward the roadway approaches in the immediate vicinity of the grade crossing.

Crossing Closure and Paired One-Way Streets

The crossing closure option and the paired one-way streets with full closure gates option are the least expensive safety enhancement options that permit the locomotive engineer to desist from activation of the train horn for that grade crossing. However, these options were eliminated from the investigation because they were not considered to be viable options at any of the crossings in DeKalb except at the 2nd and 3rd Street grade crossings which currently are paired one-way streets and have full closure gates.

Median Barriers or Channelization Devices

The installation of median barriers or channelization devices in combination with two-quadrant gates at a grade crossing will permit the locomotive engineer to desist from activation of the train horn for that grade crossing. Median barriers or channelization devices in combination with two-quadrant gates are intended to constrain vehicles to wait in their lane until the train passes through the grade crossing. The line of median barriers begins at the end of the railroad gate when in its horizontal (down) position, thus obstructing the gate runaround scenario and preventing accidents. The FRA recommended length of the line of median barriers is 100 feet, with 60 feet minimum. Therefore, median barriers will impact traffic maneuverability to and from entrances or driveways which are located in the near vicinity of the grade crossing. Median barriers may also encumber conventional and emergency vehicles if the railroad warning system malfunctions and the gate arms remain stuck in the horizontal position. However, emergency vehicles usually have the ability to ride over 6 inch to 9inch barrier curbs and the "Qwick Kurb" type barriers. Median barriers are relatively inexpensive as compared to other safety enhancement options. Appendix B, page 52, shows the "Qwick Kurb" type barriers that were installed at the Route 12 and Llanos Street grade crossings in Cortland, Illinois. These reflective barriers are designed to spring back to a vertical position after impact.

Four-Quadrant Gates

The installation of four quadrant gates at a grade crossing will permit the locomotive engineer to cease activation of the train horn at that grade crossing. Four quadrant gates are intended to completely block all road lanes on both sides of the tracks at the grade crossing and thus eliminate the gate runaround scenario. They are effective in preventing accidents but could conceivably trap slow moving vehicles in the railroad zone after the gates descend. Vehicle Presence Detectors (VPD) are often installed that sense the presence of slow moving vehicles to keep the "supplemental" exit gate arms raised or in the vertical position until all vehicles have cleared the railroad zone. Four quadrant gates may also encumber the flow of conventional and emergency vehicles through the grade crossing area in the event of a power interruption or railroad warning system malfunction and the gates remain stuck in the horizontal position. However, the fail-safe mode of the system requires the "supplemental" exit gates to remain raised or in the vertical position to allow mobility of vehicles under police supervision. The estimated capital cost for a four quadrant gate system at a crossing is $304,800 and includes $10,000 for design by Union Pacific, $244,000 for material, equipment and labor and 20% contingencies.

Video Enforcement

The installation of video enforcement in combination with two-quadrant gates at a grade crossing will permit the locomotive engineer to cease activation of the train horn at that grade crossing. Video equipment monitors the vehicle traffic flow at the grade crossing and records traffic violations. Such violations could involve vehicles attempting to runaround the railroad gates. The surveillance system is intended to be constant but the camera only activates and records an event when a violation is detected. Video enforcement does not provide any complimentary physical protection to compensate for the elimination of the train horn warning, which is what the median barriers and four quadrant gates provide. Video enforcement is an "after the fact" safety enhancement option. Video enforcement will not prevent accidents under the scenario when the first train has just vacated the crossing on one track and an impatient driver, who hears no train horn warning, attempts to maneuver around the horizontal gates as the second train arrives at the crossing in the opposite direction on the second track. Although local driver responsibility may improve due to the awareness of video enforcement, out of town vehicle behavior may be at risk since there is no audible alarm, except for bells. There is also the concern that a judge may not accept video enforcement to convict errant or negligent drivers. Without court enforcement, this alternative would fail to provide the intended safety enhancement. It is also noted that video equipment requires continuous monitoring and ongoing maintenance by the City. The estimated capital cost for the installation of a video enforcement system at a crossing is $90,000 and includes $10,000 for design, $65,000 for equipment and installation and 20% contingencies. The ongoing maintenance is estimated at $2,500 per year.

Automated Train Horns

The installation of automated train horns (ATHs) at a grade crossing, if formally approved by the FRA, will permit the locomotive engineer to cease activation of the train horn at that grade crossing. The automated train horns are part of a stationary alarm system that is interconnected to the railroad's traffic control warning circuitry at the crossing. Coordination and agreement with the railroad is required for them to interconnect the ATH system within their traffic control warning circuitry and issue instructions to their train crews regarding the silencing of the train horn. The circuitry at the crossing must be designed to provide a constant warning time regardless of the train's speed. The installation of constant warning time circuitry can be a significant additional expense if this type of circuitry does not already exist.

The ATHs are mounted on poles at the crossing and emit a louder, longer and more consistent audible alarm in the immediate vicinity of the crossing than the conventional train horn. The ATH noise is directed right toward motorists and pedestrians on the roadway. Automated train horns typically provide a minimum of 25 to 30 seconds of audible warning. The automated train horns are designed to sound like a train horn. The circuit control board, upon receipt of the signal from the railroad's signal house, cycles through the standard railroad whistle pattern of two long blasts and one short blast followed by another long blast. This pattern continues until the train reaches the crossing and then the ATHs stop sounding. When the train activates the crossing signal system, the ATHs and horn confirmation signal are activated. As long as the locomotive engineer can see the horn confirmation signal, he will not be required to sound the train horn unless he detects some type of emergency. If the locomotive engineer can not see the horn confirmation signal at the crossing, he is instructed to sound the train horn. The horn confirmation signal is only activated if the speaker located in the horn detects the alarm sound at the required decibel level. If for some reason the ATH components fail then the horn confirmation signal will not be activated and the engineer is instructed to sound the train horn.

Some public officials involved with grade crossing safety believe that ATHs are safer than conventional horns because they focus the audible alarm right at the motorist. The sound level of the audible alarm in the immediate vicinity of the crossing is higher than the conventional horn located on the locomotive. The following table developed by Railroad Controls Limited illustrates the sound levels for a motorist at varying distances from a grade crossing when the train is ¼ mile from the crossing. The locomotive horn provides a significantly lower decibel level alarm than the ATH which is mounted at the crossing and directed toward the motorist.

MOTORIST DISTANCE FROM CROSSING	LOCOMOTIVE HORN	AUTOMATED TRAIN HORN
50 FEET	78.0 dB	98.9 dB
100 FEET	73.6 dB	93.7 dB

200 FEET	75.0 dB	84.9 dB
300 FEET	67.8 dB	79.5 dB
400 FEET	64.0 dB	73.7 dB

However, some FRA officials involved with grade crossing safety believe that ATHs are less safe than conventional horns because the "Doppler Effect" of the conventional locomotive horn is missing from the ATH system. They point out that the public should be able to conclude from which direction the train is approaching upon hearing the train alarm and their concern has been that the ATH does not provide the public with that recognition. However, other safety experts in the industry acknowledge that often the public does not know from which direction the train is approaching with the conventional locomotive horn because either the vehicle windows are up, the car radio is on or people are not paying that close of attention.

It is estimated the noise from ATHs impact less than 10% of the area impacted by the noise from a conventional locomotive horn. Appendix F, page 83, provides a schematic indicating the comparative noise footprint of the area impacted by the sound of the conventional locomotive horn vs. the ATH. The following table developed by Railroad Controls Limited illustrates this reduction in area affected by horn noise for various decibel levels with the installation of automated train horns.

SOUND LEVEL	LOCOMOTIVE HORN	AUTOMATED TRAIN HORN	% REDUCTION
> 80 Db	124.7 AC	3.8 AC	97.0 %
> 85 Db	55.7 AC	1.8 AC	96.8 %
> 90 Db	24.8 AC	0.8 AC	96.8 %
> 95 Db	11.5 AC	0.3 AC	97.4 %
> 100 Db	5.7 AC	0.2 AC	96.5 %

The estimated design and construction engineering cost for ATHs is $15,000 per crossing. The estimated cost for ATHs equipment at a two-track crossing is $36,000 and includes two poles, two horns, two horn confirmation signals, master and slave controllers and cabinet. The estimated installation cost, excluding Union Pacific involvement but including underground cable and conduit, is $30,000 per crossing using contracted labor and equipment. The estimated cost for the Union Pacific to install new circuits in their signal cabinet is $2,500 per crossing. The initial capital expense for design, equipment and installation is estimated at $100,000 ($15,000 + $36,000 + $30,000 + $2,500 plus 20% contingencies) for a two-track crossing. The estimated ongoing annual maintenance is $1,000 per crossing.

Appendix B, page 51 shows the automated train horns that were installed at the Route 70 grade crossing in Mundelein, Illinois.

Safety Enhancement Option Evaluation Methodology

The following grade crossings were included in the investigation: 1st Street, the Route 23 and Route 38 Intersection, 6th Street, 7th Street and 10th Street. The 2nd and 3rd Street grade crossings already are paired one-way streets with full closure gates and thus qualify now for elimination of the locomotive horn. Therefore, the 2nd and 3rd Street grade crossings did not receive the full investigative treatment as the other crossings since they presently have approved FRA safety enhancement features. The following four safety enhancement options were evaluated at each crossing: median barriers or channelization devices in combination with two-quadrant gates, four quadrant gates, video enforcement in combination with two-quadrant gates, and automated train horns.

Matrices were developed to evaluate the above four safety enhancement options at the various grade crossings in DeKalb. The evaluation matrices for each of the four safety enhancement options at each grade crossing are individually included in Appendix A. The evaluation is achieved by comparing the cost per total weighted benefit unit of each of the four safety enhancement options at each of the crossings. The safety enhancement option with the lowest cost per total weighted benefit unit is expected to provide the most value at the least cost.

The evaluation included a multi-step procedure. The following steps, A through M, are involved:

A. <u>Establish the criteria to evaluate the four safety enhancement options.</u>

The following seven criteria were established to evaluate the four safety enhancement options:

1. Effect on vehicular public in terms of safety
2. Effect on Railroad in terms of accident liability
3. Effect on pedestrian public in terms of safety
4. Effect on vehicular and pedestrian public in terms of convenience
5. Effect on emergency vehicles in terms of convenience
6. Effect on nearby neighborhood in terms of noise annoyance
7. Effect on City as a whole in terms of noise annoyance

Although there are numerous criteria that could be studied, all can be categorized into three broad categories: safety, convenience, and noise annoyance. We chose to refine those three categories into the above seven criteria to provide further definition to the study. Because of the subjectivity of the study, any further refinement, such as pedestrians versus bicyclists or ambulances versus police vehicles versus fire trucks, was deemed unnecessary.

B. <u>Determine the priority of each criterion.</u>

Each criterion held a different priority in the evaluation process depending on its importance to meeting the City's objectives. Therefore, each criterion was assigned a weight (%) to reflect its subjective prioritization. Because the effect of any of the enhancement options can be categorized into safety, convenience, and noise annoyance, the sum total of all the weights was assigned 100%, to represent the whole of the priority assessment. These assigned weights remain constant throughout the evaluation process for each safety enhancement option at each grade crossing. The following priority weights were assigned to each criterion based upon our assessment of the City of DeKalb and its objectives. That assessment was determined through consideration of the departments of public works, police, and fire and from our field observations of train and vehicular movements at each grade crossing.

1. Effect on vehicular public in terms of safety	25%
2. Effect on Railroad in terms of accident liability	5%
3. Effect on pedestrian public in terms of safety	15%
4. Effect on vehicular and pedestrian public in terms of convenience	20%
5. Effect on emergency vehicles in terms of convenience	5%
6. Effect on nearby neighborhood in terms of noise annoyance	5%
7. Effect on City as a whole in terms of noise annoyance	25%
	100%

The first three criteria relate to safety and comprise 45% of the total priority to the City. Criteria 4 and 5 relate to traffic maneuverability or convenience and consume 25% of the total priority to the City. Criteria 6 and 7 relate to noise annoyance and add up to 30% of the total priority to the City.

C. Assign benefit ratings for each of the seven criteria.

A benefit rating scale from –5.0 to +5.0 was established to evaluate the relative depreciation or improvement of conditions at each crossing as a result of the use of a specific safety enhancement option based on the specific criterion. The rating assignments on the scale are defined as follows:

RATING ASSIGNMENT	DEFINITION
-5.0	the maximum depreciation of conditions based on criteria
-4.0	a significant depreciation of conditions based on criteria
-3.0	a medium depreciation of conditions based on criteria
-2.0	a modest depreciation of conditions based on criteria
-1.0	minimal depreciation of conditions based on criteria
0.0	no change in conditions based on criteria
+1.0	minimal improvement of conditions based on criteria
+2.0	a modest improvement of conditions based on criteria
+3.0	a medium improvement of conditions based on criteria
+4.0	a significant improvement of conditions based on criteria
+5.0	the maximum improvement of conditions based on criteria

D. Obtain the weighted benefit of each criterion for each safety enhancement option at a specific crossing.

This is performed by multiplying the weighted priority of each of the seven criterion by its respective benefit rating. It is noted the weighted benefit of a criterion may be less than zero.

E. Determine the total weighted benefit for a specific safety enhancement option at a specific crossing.

This is performed by summing the individual weighted benefits for the various criteria developed in Step 4. If the total weighted benefit for a specific safety enhancement option is less than zero, then that specific safety enhancement option is eliminated from further consideration because it results in a general depreciation of conditions based on the seven criteria.

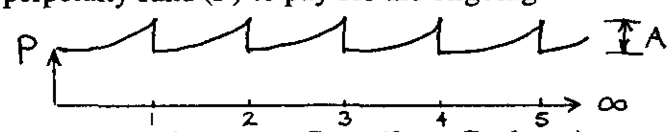
F. Determine the initial capital investment for a specific safety enhancement option at a specific crossing.

G. Determine the estimated annual cost of the ongoing maintenance for a specific safety enhancement option at a specific crossing.

H. Determine the capitalized cost of the ongoing maintenance.

The capitalized cost of the ongoing maintenance is the amount of money that must be invested today to generate sufficient income to pay for perpetual disbursements for the ongoing maintenance. The capitalized cost of the ongoing maintenance is equated to the establishment of a perpetuity fund (P) to pay for the ongoing maintenance:

$$(P) = \frac{A}{i}$$



A = Estimated Annual Maintenance Cost (from G. above)
i = Interest rate (7%)

An average investment rate of 7% was used because at times, such as today's financial climate, interest rates may be as low as 3% and at other times they may be as high as or higher than 10%.

I. Determine the estimated cost of periodic equipment replacement for a specific safety enhancement option at a specific crossing.

J. Determine the capitalized cost of the periodic equipment replacement.

The capitalized cost of periodic equipment replacement is the amount of money that must be invested today to generate sufficient income to pay for the periodic replacement of equipment for an infinite period of time. The capitalized cost of the periodic equipment replacement is equated to the establishment a perpetuity fund (X) to pay for the periodic replacement of equipment:

$$(X) = \frac{S}{[(1+i)^n]-1}$$

S= Estimated cost of periodic equipment replacement (from I. above)
i = Interest rate (7%)
n = estimated life cycle of equipment (20 years)

A life of 20 years was used for both video enforcement and automated train horn equipment based on discussions with equipment manufacturers.

K. Determine the total capitalized cost of the specific safety enhancement option at a specific crossing.

This is performed by summing the initial capital investment, the capitalized cost of the ongoing maintenance (P) and the capitalized cost of the periodic equipment replacement (X) from Steps F., H. and J. above.

L. Determine the cost per total weighted benefit unit of a specific safety enhancement option at a specific crossing.

This is performed by dividing the total capitalized cost of a specific safety enhancement option at a specific crossing by its total weighted benefit.

M. Determine the most cost effective safety enhancement option at a specific crossing.

This is performed by ranking the various costs per total weighted benefit unit for each specific safety enhancement option. The safety enhancement option with the lowest cost per total weighted benefit unit should be selected at the crossing because it provides the most value at the least cost.

The above methodology for evaluation of the various safety enhancement options at a grade crossing may be further understood by progressing through the following evaluation of the 1st Street grade crossing.

The Median Barriers safety enhancement option at the 1st Street grade crossing was evaluated by assigning benefit ratings as follows for each of the seven criteria:

Effect on vehicular public in terms of safety	-1.0 (Comment #1)
Effect on Railroad in terms of accident liability	+3.0 (Comment #2)
Effect on pedestrian public in terms of safety	-1.5 (Comment #3)
Effect on vehicular and pedestrian public in terms of convenience	-5.0 (Comment #4)
Effect on emergency vehicles in terms of convenience	-3.0 (Comment #5)
Effect on nearby neighborhood in terms of noise annoyance	+3.0 (Comment #6)
Effect on City as a whole in terms of noise annoyance	+5.0 (Comment #7)

Comment #1: Although medians provide a physical barrier that greatly eliminates the potential for gate runaround accidents, median barriers will likely result in a higher incidence of vehicular accidents as cars occasionally attempt to negotiate the barriers at the nearby entrance locations of Walgreens and the Tom Sparks Buick.

Comment #2: Median barriers result in physical train/vehicle separation. Median barriers therefore greatly reduce the potential for gate runaround accidents.

Comment #3: Pedestrians do not benefit from median barriers. The elimination of the train horn warning may compromise safety since pedestrians must rely only on the existing pedestrian gates, flashers and bells to recognize an approaching train.

Comment #4: Median barriers will block the entrance locations of Walgreens and to Tom Sparks Buick. Medians at this crossing would be very problematic to users of these business entrances.

Comment #5: Emergency vehicles will be somewhat encumbered if warning devices malfunction and gates remain stuck in horizontal position. However, emergency vehicles will have ability to ride over 6 inch to 9 inch barriers curbs and "Qwick Kurbs".

Comment #6: Median barriers will result in the elimination of train horn noise. The only remaining audible alarm is the ringing of bells at the crossing.

Comment #7: Median barriers will result in the elimination of train horn noise and the City will experience significant reduction in train horn noise.

The weighted benefit for each criterion is calculated as follows:

Criteria	Priority Weight (%)	x	Benefit Rating	=	Weighted Benefit
Effect on vehicular public in terms of safety	25	x	-1.0	=	-0.25
Effect on Railroad in terms of accident liability	5	x	+3.0	=	+0.150
Effect on pedestrian public in terms of safety	15	x	-1.5	=	-0.225
Effect on public in terms of convenience	20	x	-5.0	=	-1.0
Effect on emerg. vehicles in terms of convenience	5	x	-3.0	=	-0.15
Effect on neighborhood in terms of noise annoyance	5	x	+3.0	=	+0.15
Effect on City in terms of noise annoyance	25	x	+5.0	=	+1.25
	100%				-0.075

Median barriers are rejected for further evaluation at the 1st street grade crossing since its total weighted benefit is less than zero.

The Four Quadrant Gate safety enhancement option at the 1st Street grade crossing is now evaluated by assigning benefit ratings as follows for each of the seven criteria:

Effect on vehicular public in terms of safety	+4.5 (Comment #1)
Effect on Railroad in terms of accident liability	+3.5 (Comment #2)
Effect on pedestrian public in terms of safety	-0.5 (Comment #3)
Effect on vehicular and pedestrian public in terms of convenience	-1.5 (Comment #4)
Effect on emergency vehicles in terms of convenience	-1.5 (Comment #5)
Effect on nearby neighborhood in terms of noise annoyance	+3.0 (Comment #6)
Effect on City as a whole in terms of noise annoyance	+5.0 (Comment #7)

Comment #1: Four quadrant gates provide the maximum level of physical protection at a grade crossing. However, there is the potential hazard of vehicles being trapped in the railroad zone. Vehicle Presence Detectors (VPD) may prevent vehicles from being trapped in railroad zone by keeping the supplemental gates raised until the vehicle has cleared.

Comment #2: Four quadrant gates greatly reduce accident exposure at grade crossing. However, there is the potential hazard of vehicles being trapped in the railroad zone. Vehicle Presence Detectors (VPD) may prevent vehicles from being trapped in railroad zone.

Comment #3: Pedestrians can duck under 4-quad gates as easily as 2-quad gates. The elimination of the train horn warning may reduce safety since pedestrians must only rely on existing pedestrian gates, flashers and bells to provide protection.

Comment #4: In the event of system malfunction, four quadrant gates will encumber the vehicle traffic flow. This inconvenience may be mitigated somewhat because the fail-safe mode of the system requires the supplemental gates to remain raised or in the vertical position to allow mobility of vehicles under police supervision.

Comment #5: In the event of system malfunction, four quadrant gates will encumber emergency vehicles. This encumbrance may be mitigated somewhat because the fail-safe mode of the system requires the supplemental gates to remain raised or in the vertical position to allow mobility of emergency vehicles.

Comment #6: Four quadrant gates will result in the elimination of train horn noise. The only remaining audible alarm is the ringing of bells at the crossing.

Comment #7: Four quadrant gates will result in the elimination of train horn noise and the City will experience significant reduction in train horn noise.

The weighted benefit for each criterion is calculated as follows:

Criteria	Priority Weight (%)	x	Benefit Rating	=	Weighted Benefit
Effect on vehicular public in terms of safety	25	x	+4.5	=	+1.125
Effect on Railroad in terms of accident liability	5	x	+3.5	=	+0.175
Effect on pedestrian public in terms of safety	15	x	-0.5	=	-0.075

Effect on public in terms of convenience	20	x	-1.5	=	-0.300
Effect on emerg. vehicles in terms of convenience	5	x	-1.5	=	-0.075
Effect on neighborhood in terms of noise annoyance	5	x	+3.0	=	+0.150
Effect on City in terms of noise annoyance	25	x	+5.0	=	+1.250
	100%				+2.250

Four quadrant gates have a positive weighted benefit and therefore are considered for further evaluation at the 1st Street grade crossing. The estimated capital cost (design, construction plus 20% contingencies) is $304,800 for the complete system. It is assumed that the Union Pacific Railroad will maintain the system at their expense and the City will have no financial burden associated with the ongoing maintenance or replacement of the four quadrant gates. However, it is possible that the UPRR may request that the City share in the cost for the additional maintenance effort associated with four quadrant gates.

The cost per total weighted benefit unit for the four quadrant gates at the 1st Street grade crossing is $304,800/2.25 = $135,467.

The Video Enforcement safety enhancement option at the 1st Street grade crossing is now evaluated by assigning benefit ratings as follows for each of the seven criteria:

Effect on vehicular public in terms of safety	-1.0 (Comment #1)
Effect on Railroad in terms of accident liability	+2.0 (Comment #2)
Effect on pedestrian public in terms of safety	-1.0 (Comment #3)
Effect on vehicular and pedestrian public in terms of convenience	0 (Comment #4)
Effect on emergency vehicles in terms of convenience	0 (Comment #5)
Effect on nearby neighborhood in terms of noise annoyance	+3.0 (Comment #6)
Effect on City as a whole in terms of noise annoyance	+5.0 (Comment #7)

Comment #1: Video Enforcement may result in the improvement of local driver responsibility but out of town vehicle behavior may be at risk. The elimination of the train horn is not replaced by additional physical protection at grade crossing.

Comment #2: Video Enforcement may provide evidence that a driver disregarded warning devices in the event of accident thus relieving the Union Pacific Railroad of liability. However, Video Enforcement may also provide evidence of malfunction of warning devices thus increasing Railroad liability.

Comment #3: Video Enforcement will not result in the improvement of pedestrian responsibility. Pedestrians must rely only on gates, flashers and bells but not the audible train horn alarm.

Comment #4: Video Enforcement will result in no change to vehicular and pedestrian convenience.

Comment #5: Video Enforcement will result in no change to emergency vehicular convenience.

Comment #6: Video Enforcement will result in the elimination of train horn noise. The only remaining audible alarm is the bells at the crossing.

Comment #7: Video Enforcement will result in the elimination of train horn noise and the City will experience significant reduction in train horn noise.

The weighted benefit for each criterion is calculated as follows:

Criteria	Priority Weight (%)	x	Benefit Rating	=	Weighted Benefit
Effect on vehicular public in terms of safety	25	x	-1.0	=	-0.25
Effect on Railroad in terms of accident liability	5	x	+2.0	=	+0.10
Effect on pedestrian public in terms of safety	15	x	-1.0	=	-0.15
Effect on public in terms of convenience	20	x	0.0	=	0.00
Effect on emerg. vehicles in terms of convenience	5	x	0.0	=	0.00
Effect on neighborhood in terms of noise annoyance	5	x	+3.0	=	+0.150
Effect on City in terms of noise annoyance	25	x	+5.0	=	+1.250
	100%				+1.10

Video Enforcement has a positive weighted benefit and therefore is considered for further evaluation at the 1st Street grade crossing. The estimated capital cost (design, construction plus 20% contingencies) is $90,000 for the complete system. The estimated annual maintenance costs are $2,500. The estimated capitalized cost of the ongoing maintenance, using 7% interest, is $35,714. The estimated capitalized cost of the periodic $65,000 replacement of the video enforcement automatic system, based on a 20-year life and 7% interest is $22,651. The total cost including the up-front capital expenditure and the maintenance and replacement perpetuities is $90,000 + $35,714 + $22,651 = $148,365.

The cost per total weighted benefit unit for Video Enforcement at the 1st Street grade crossing is $148,365/1.10 = $134,877.

The Automated Train Horn safety enhancement option at the 1st Street grade crossing is now evaluated by assigning benefit ratings as follows for each of the seven criteria:

Effect on vehicular public in terms of safety	+1.0 (Comment #1)
Effect on Railroad in terms of accident liability	+0.5 (Comment #2)
Effect on pedestrian public in terms of safety	+1.0 (Comment #3)
Effect on vehicular and pedestrian public in terms of convenience	0 (Comment #4)
Effect on emergency vehicles in terms of convenience	0 (Comment #5)
Effect on nearby neighborhood in terms of noise annoyance	-1.5 (Comment #6)
Effect on City as a whole in terms of noise annoyance	+4.5 (Comment #7)

Comment #1: The Automated Train Horn Alarm is focused toward the vehicle approaching the crossing and is more audible to the vehicular public than the locomotive horn resulting in marginal safety improvement.

Comment#2: The Automated Train Horn system may require a City - Railroad Agreement that results in railroad indemnification to reduce Union Pacific liability under certain conditions.

Comment#3: The Automated Train Horn Alarm is more audible at the crossing than the locomotive horn resulting in marginal safety improvement for pedestrians.

Comment#4: The Automated Train Horn will result in no change to vehicular and pedestrian convenience.

Comment#5: The Automated Train Horn will result in no change to emergency vehicular convenience.

Comment#6: The Automated Train Horn will result in the elimination of the train horn but the noise in the immediate vicinity of the crossing will increase.

Comment#7: The Automated Train Horn will result in the elimination of train horn noise and the City will experience significant reduction in train horn noise. The weighted benefit for each criterion is calculated as follows:

Criteria	Priority Weight (%)	x	Benefit Rating	=	Weighted Benefit
Effect on vehicular public in terms of safety	25	x	+1.0	=	+0.25
Effect on Railroad in terms of accident liability	5	x	+0.50	=	+0.025
Effect on pedestrian public in terms of safety	15	x	+1.0	=	+0.15
Effect on public in terms of convenience	20	x	0.0	=	0.00
Effect on emerg. vehicles in terms of convenience	5	x	0.0	=	0.00
Effect on neighborhood in terms of noise annoyance	5	x	-1.5	=	-0.075
Effect on City in terms of noise annoyance	25	x	+4.5	=	+1.125
	100%				+1.475

Automated Train Horns have a positive weighted benefit and therefore are considered for further evaluation at the 1st Street grade crossing. The estimated capital cost for design, equipment, material, labor including 20% contingencies is $100,200 for the complete system. The estimated annual maintenance costs are $1,000. The estimated capitalized cost of the ongoing maintenance, using 7% interest, is $14,286. The estimated capitalized cost of the periodic replacement of the automatic train horn equipment in the amount of $66,000, based on a 20-year life and 7% cost of capital is $22,999. The total cost for the up-front capital expenditure and the maintenance and equipment replacement perpetuities is $100,200+$14,286+$22,999 = $137,485.

The cost per total weighted benefit unit for Automated Train Horns at the 1st Street grade crossing is $137,485/1.475 = $93,210.

A summary of the 1st Street evaluation follows:

Safety Enhancement Option	Cost per total weighted benefit unit
Median Barriers	weighted benefit < 0, not a viable candidate
Four Quadrant Gates	$135,467
Video Enforcement	$134,877
Automated Train Horns	$ 93,210.

A comparison of the various safety enhancement options at 1st Street reveals that Automated Train Horns are the most cost effective safety enhancement option that results in the mitigation of locomotive horn noise.

Grade Crossing Analysis

First Street

The 1st Street grade crossing is the western most grade crossing in DeKalb. First Street is a two-lane street with sidewalks on both sides. Flashing light signals with automatic two-quadrant gates protect the vehicular public and pedestrian gates protect sidewalk users from the double track mainline that crosses 1st Street at a slight skew. An entrance to the Tom Sparks Buick dealership is located near the southeast quadrant and an entrance to Walgreen's Drug is located near the northwest quadrant. See the Photos of the 1st Street grade crossing in Appendix B, page 53.

Median barriers in advance of the crossing would impact traffic ingress and egress associated with these businesses. Median barriers, if installed, may also cause accidents if vehicles attempt to negotiate the barriers near the entrance locations. Median barriers have a negative total weighted benefit and therefore are not a viable safety enhancement option.

Video Enforcement has a higher cost per total weighted benefit unit than either four quadrant gates or automated train horns. Four quadrant gates have a higher cost per total weighted benefit unit than automated train horns.

Although ATHs do not completely eliminate train noise, they do mitigate train noise without compromising public safety or encumbering vehicular maneuverability. Automated train horns are the most cost effective safety enhancement option at the 1st Street grade crossing and therefore are the recommended safety enhancement option. The 1st Street grade crossing evaluation matrices are located in Appendix A, pages 31 through 34. The evaluation of the 1st Street grade crossing was discussed in the example presented on pages 13 through 19. A Concept Plan showing the approximate locations of the automated train horns at the 1st Street crossing is included in Appendix C, page 62.

Second Street

Second Street is a two lane one way street with southbound traffic. The pavement width reduces in the vicinity of the crossing and the pavement markings indicate one lane across the tracks. Sidewalks exist on both sides of the Street. Flashing light signals with automatic gates on both sides of the street protect the southbound traffic and pedestrian gates protect sidewalk users from the double track mainline which crosses 2nd Street at a slight skew. An entrance to a parking lot is located near the northwest quadrant and an entrance to a railroad maintenance alley between 2nd and 3rd Streets is located near the northeast quadrant. The intersection with Grove Street is located near the southeast quadrant. The Photos of the 2nd Street grade crossing are located in Appendix B, page 54.

Third Street

Third Street is a two lane one way street with northbound traffic. The pavement width reduces in the vicinity of the crossing and the pavement markings indicate one lane across the tracks. Sidewalks exist on both sides of the Street. Flashing light signals with automatic gates on both sides of the street protect the northbound traffic and pedestrian gates protect sidewalk users from the double track mainline which crosses 3rd Street at a slight skew. An entrance to a railroad maintenance alley between 2nd and 3rd Streets is located near the northwest quadrant. An entrance to a dumpster is located near the northwest quadrant. An entrance for a building is located near the southwest quadrant. An entrance to a parking lot is located near the southeast quadrant. The Photos of the 3rd Street grade crossing are located in Appendix B, page 55.

Second and Third Streets are paired one way streets and since they already have flashing light signals with automatic gates on both sides of the street fully protecting the approach lanes, they qualify now for elimination of the locomotive horn. Therefore, no further investment in safety enhancement equipment is needed at the 2nd and 3rd Street grade crossings.

State Route 23 and State Route 38 Intersection

State Route 23 (4th Street) and State Route 38 (Lincoln Avenue) intersect at right angles approximately in the middle of the City of DeKalb, one block north of City Hall. State Route 23 and State Route 38 are both two lanes in each direction in the vicinity of the intersection but the four travel lanes are approximately only 10 feet wide. Both State Route 23 and State Route 38 have sidewalks on both sides of their respective travel ways in the vicinity of the grade crossing. Flashing light signals with automatic gates protect the vehicular public and pedestrian gates protect sidewalk users from the double track mainline. This intersection is characterized by the high volume of truck and automobile traffic negotiating the sharp turning radii. Semi-trucks often must occupy more than their lane to accomplish the turn from 4th to Lincoln and vice versa. Traffic movement through the intersection is compounded by the double track mainline which extends through the intersection at a skew. Entrances to parking lots for an optometrist's office and a small restaurant are located off Route 23 in the southwest and southeast quadrants in the immediate vicinity of the grade crossing. The entrance to the Lovell's Tire parking lot is located off Route 38 in the southeast quadrant in the close vicinity of the grade crossing. An out of service bank building is located in the northwest quadrant. The Photos of the Route 23 and State Route 38 intersection grade crossing are located in Appendix B, pages 56, 57 and 58.

Median barriers in advance of this four-approach grade crossing would negatively impact traffic ingress and egress associated with the business entrances. Median barriers, if installed, may also cause accidents if vehicles attempt to negotiate the barriers near the entrance locations. Median barriers, if installed, may also cause accidents and obstruct trucks turning from one street to the other. Median barriers have a negative weighted benefit and therefore are not a viable safety enhancement option at the State Route 23 and State Route 38 intersection.

Four Quadrant Gates will eliminate train horn noise at the State Route 23 and State Route 38 intersection. Because four sets (eight gates) will be needed the estimated capital cost is double. In addition, the four quadrant gates, as they begin to descend, may encumber traffic flow and result in a higher incidence of vehicular accidents. Four quadrant gates have a higher cost per total weighted benefit unit than either Video Enforcement or Automated Train Horns.

Video enforcement allows silencing the locomotive horn noise but has a higher cost per total weighted benefit unit than Automated Train Horns. Since the State Route 23 and State Route 38 grade crossing has four, not two, approaches, it would require twice the equipment at the intersection, which would require more maintenance and monitoring.

ATHs would mitigate train noise and provide directed horn noise without compromising public safety or encumbering vehicular maneuverability at this challenging crossing. Although four sets would be required, automated train horns are the most cost effective safety enhancement option at the State Route 23 and State Route 38 grade crossing. Therefore, ATHs are the recommended safety enhancement option at the State Route 23 and State Route 38 Grade Crossing. The State Route 23 and State Route 38 grade crossing evaluation matrices are located in Appendix A, pages 35 through 38.

A summary of the State Route 23 and State Route 38 intersection evaluation is as follows:

Safety Enhancement Option	Cost per total weighted benefit unit
Median Barriers	weighted benefit < 0, not a viable candidate
Four Quadrant Gates	$420,414
Video Enforcement	$269,754
Automated Train Horns	$186,420

A Concept Plan showing the approximate locations of the automated train horns at the State Route 23 and State Route 38 grade crossing is included in Appendix C, page 63.

It is our understanding that Illinois DOT is currently investigating possible geometry improvements to the State Route 23 and State Route 38 intersection. Future geometry improvements at the intersection may require the relocation of existing traffic control devices and the proposed ATHs.

Sixth Street

Sixth Street, at the grade crossing, is two lanes northbound and one lane southbound. Sidewalks are located on both sides of the Street. Flashing light signals with automatic gates protect the vehicular public from the double track mainline that crosses 6^{th} Street at a slight skew. Pedestrian gates protect sidewalk users on the east sidewalk but there are no pedestrian gates for the west sidewalk on either the north or south approach. An entrance to a McDonalds restaurant is located near the southwest quadrant. An entrance to an alley, south of the old station building that is now occupied by Union Pacific Railroad maintenance personnel, is located near the southeast quadrant. An entrance to a parking lot used by Union Pacific Railroad personnel is located near the northeast quadrant. The Photos of the 6th Street grade crossing are located in Appendix B, page 59.

The 6th Street grade crossing is the most likely candidate for closure if that safety enhancement option was acceptable to DeKalb as a method to eliminate train noise. Sixth Street is not a major north - south route in DeKalb and terminates ½ block south of the crossing at Lincoln Avenue (Route 38). It is noted that 4th Street (Route 23) and 7th Street are major north – south routes and cross the tracks at-grade two blocks to the west and one block to the east respectively from the 6th Street crossing. The Union Pacific has stated that they would like the 6th Street crossing to be closed.

Median barriers in advance of the crossing would negatively impact traffic ingress and egress associated with the McDonalds restaurant and the UPRR alley entrance and the UPRR parking lot. Median barriers, if installed, may also cause accidents if vehicles attempt to negotiate the barriers near the entrance locations. Median barriers have a negative total weighted benefit at the 6th Street grade crossing and therefore are not a viable safety enhancement option.

Video Enforcement eliminates train horn noise but has a higher cost per total weighted benefit unit than either Four Quadrant Gates or Automated Train Horns.

Four Quadrant Gates eliminates train horn noise but they have a higher cost per total weighted benefit unit than Automated Train Horns. The Union Pacific has advised that they will not allow the existing gate arms to be lengthened to block both the approach and exit traffic lanes to achieve the effect of Four Quadrant gates. This is because the longer gates, upon arrival of a train, may block slower moving vehicular traffic from safely vacating the crossing area. With Four Quadrant gates, the additional two "left-hand" gates, that prevent vehicular traffic runarounds, descend several seconds after the main gates descend. Reference is made to the telephone conversation with Tom Zappler in Appendix D. Also, in the event of equipment malfunction, only these supplemental gates may be raised to allow the movement of vehicular traffic through the grade crossing under the supervision of police.

Although ATHs do not completely eliminate train noise, they do mitigate train noise without compromising public safety or encumbering vehicular maneuverability. Automated Train Horns are the most cost effective safety enhancement option at the 6th Street grade crossing and therefore, are the recommended safety enhancement option. The 6th Street grade crossing evaluation matrices are located in Appendix A, pages 39 through 42.

The summary of the 6th Street evaluation is as follows:

Safety Enhancement Option	Cost per total weighted benefit unit
Median Barriers	weighted benefit < 0, not a viable candidate
Four Quadrant Gates	$135,467
Video Enforcement	$134,877
Automated Train Horns	$ 93,210

A Concept Plan showing the approximate locations of the automated train horns at the 6th Street grade crossing is included in Appendix C, page 64.

Seventh Street

Seventh Street, at the grade crossing, is two lanes northbound and one lane southbound. Sidewalks are located on both sides of the Street. Flashing light signals with automatic gates protect the vehicular public from the double track mainline that crosses 7th Street at a slight skew. Pedestrian gates protect sidewalk users on the west sidewalk but there are no pedestrian gates for the east sidewalk on either the north or south approach. Locust Street runs approximately parallel to the tracks but makes a jog through the 7th Street crossing. Locust Street therefore intersects with 7th Street ½ block north of the crossing and ½ block south of the crossing. An entrance to the alley south of the old station building, now occupied by Union Pacific Railroad maintenance personnel, is located near the southwest quadrant. It is also our understanding that Allied Van Lines operates from this alley between 6th and 7th Streets. A track used by the Union Pacific to store track maintenance equipment crosses 7th Street approximately 50 feet north of the northerly mainline track. This UPRR track stub ends just east of 6th Street. A pair of industry tracks also crosses 7th Street approximately 180 feet north of the northerly mainline track. The Photos of the 7th Street grade crossing are located in Appendix B, page 60.

The UPRR Manager of Track Maintenance that is responsible for the territory that includes Dekalb recently advised that they will permanently remove their maintenance track from the 7th Street crossing as part of the 7th Street grade crossing rehabilitation project that will be initiated in September 2002. Reference is made to the telephone conversation with Jim Nudera in Appendix D, page 77. This soon to be removed track will therefore not interfere with median barriers if they were installed in advance of the crossing from the north. However, a 60-foot long row of median barriers north of the crossing will obstruct northbound 53-foot long semi-trailers on 7th Street from turning west onto Locust Street north of tracks or eastbound trucks on Locust Street turning south onto 7th Street. Median barriers south of the crossing will impact left turn egress from the alley along the south side the station building between 6th and 7th Street. A 60-foot long row of median barriers south of the crossing will also prevent 53-foot long semi-trailers from turning left from northbound 7th Street into the alley. Reference is made to the drawing in Appendix E, page 82, that shows the conflict of proposed 60-foot long median barriers with 53-foot long semi-trailers turning left from northbound 7th Street into the alley or turning right from Locust Street onto southbound 7th Street.

Median barriers at the 7th Street crossing have a negative total weighted benefit and are not a viable safety enhancement option to eliminate train horn noise at the 7th Street crossing. The total weighted benefit for median barriers is fatally compromised by safety and vehicular convenience concerns.

Four Quadrant Gates eliminate train horn noise but they have a higher cost per total weighted benefit unit than video enforcement or automated train horns.

Video Enforcement eliminates train horn noise but has a higher cost per total weighted benefit unit than automated train horns.

Although ATHs do not completely eliminate train noise, they do mitigate train noise without compromising public safety or encumbering vehicular maneuverability. Automated Train Horns are the most cost effective safety enhancement option at the 7th Street grade crossing and therefore, are the recommended safety enhancement option. The 7th Street grade crossing evaluation matrices are located in Appendix A, pages 43 through 46.

The summary of the 7th Street evaluation is as follows:

Safety Enhancement Option	Cost per total weighted benefit unit
Median Barriers	weighted benefit < 0, not a viable candidate
Four Quadrant Gates	$135,467
Video Enforcement	$134,877
Automated Train Horns	$ 93,210

A Concept Plan showing the approximate locations of the automated train horns at the 7th Street grade crossing is included in Appendix C, page 65.

Tenth Street

Tenth Street, at the grade crossing, is one lane northbound and one lane southbound. The double track mainline crosses 10th Street almost at a right angle. An industry track to Nehring Electric also crosses 10th Street immediately south of the southerly mainline track. This industry track stub ends approximately 150 feet west of 10th Street. Another industry track also crosses 10th Street immediately north of the northerly mainline track. This northerly industry track serves as a lead to the pair of industry tracks discussed in the 7th Street narrative. Sidewalks are located on both sides of the 10th Street crossing. Flashing light signals with automatic gates protect the vehicular public from the four tracks crossing 10th Street. Pedestrian gates protect sidewalk users on both sidewalks for both the north and southbound approaches. An entrance to Nehring Electric is located approximately 50 feet south of the southerly industry track in the southwest quadrant. An entrance to a gravel parking lot is located approximately 50 feet south of the southerly industry track in the southeast quadrant. A wide entrance to a parking lot adjacent to a brick building is located immediately north of the northerly industry track in the northeast quadrant. A gravel entrance adjacent to a brick building is located immediately north of the northerly industry track in the northwest quadrant. The Photos of the 10th Street grade crossing are located in Appendix B, page 61.

The UPRR Manager of Track Maintenance recently advised that the UPRR will permanently remove the southerly industry track adjacent to Nehring Electric from the 10th Street crossing as part of the 10th Street grade crossing rehabilitation project that will be initiated in late September 2002. Refer to the telephone conversation with Jim Nudera in Appendix D, page 77.

It appears unlikely that the northerly industry track at the 10th Street crossing may be removed. Under current conditions, the presence of median barriers in advance of the crossing would negatively impact traffic ingress and egress associated with the entrances to businesses. Median barriers, if installed, may also cause accidents if vehicles attempt to negotiate the barriers near the entrance locations. Median barriers, under current conditions, have a negative weighted benefit and therefore are not a viable safety enhancement option.

Four quadrant gates eliminate train horn noise but they have a higher cost per total weighted benefit unit than either video enforcement or automated train horns.

Video enforcement eliminates train horn noise but has a higher cost per total weighted benefit unit than automated train horns.

Although ATHs do not completely eliminate train noise, they do mitigate train noise without compromising public safety or encumbering vehicular maneuverability. Automated Train Horns are the most cost effective safety enhancement option at the 10th Street grade crossing and therefore are the recommended safety enhancement option. The 10th Street grade crossing evaluation matrices are located in Appendix A, pages 47 through 50.

A summary of the 10th Street evaluation is as follows:

Safety Enhancement Option	Cost per total weighted benefit unit
Median Barriers	weighted benefit < 0, not a viable candidate
Four Quadrant Gates	$135,467
Video Enforcement	$134,877
Automated Train Horns	$ 93,210

A Concept Plan showing the approximate locations of the automated train horns at the 10th Street grade crossing is included in Appendix C, page 66.

Safety Enhancement Option Evaluation Summary

The cost per total weighted benefit unit for the various safety enhancement options at each grade crossing is summarized in the following chart. The chart indicates that automated train horns are the most cost effective safety enhancement option at each crossing. Automated train horns result in the least cost per total weighted benefit unit for the various safety enhancement options at each grade crossing.

		SAFETY ENHANCEMENT OPTIONS COST PER WEIGHTED BENEFIT UNIT			
CROSSING NAME	**One-Way Street with Full Closure Gates**	**Median Barriers**	**Four Quadrant Gates**	**Video Enforcement**	**Automated Train Horns**
First Street	Not a Safety Enhancement Option	Not a Safety Enhancement Option since Total Weighted Benefit is < 0.	$135,467	$134,877	$93,210
Second Street	Presently complies				
Third Street	Presently complies				
Route 23 & 38	Not a Safety Enhancement Option	Not a Safety Enhancement Option since Total Weighted Benefit is < 0.	$420,414	$269,754	$186,420
Sixth Street	Not a Safety Enhancement Option	Not a Safety Enhancement Option since Total Weighted Benefit is < 0.	$135,467	$134,877	$93,210
Seventh Street	Not a Safety Enhancement Option	Not a Safety Enhancement Option since Total Weighted Benefit is < 0.	$135,467	$134,877	$93,210
Tenth Street	Not a Safety Enhancement Option	Not a Safety Enhancement Option since Total Weighted Benefit is < 0.	$135,467	$134,877	$93,210

The total capitalized cost is the sum of the initial capital expenditure (Column A), the capitalized cost of the annual maintenance (Column C) and the capitalized cost of periodic replacement of the ATH equipment (Column E).

Cost Summary

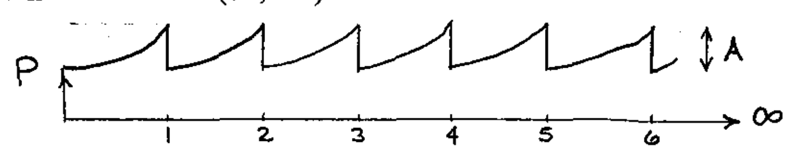
The estimated cost exposure associated with the installation of automated train horns is summarized in the following chart.

	Estimated Costs for Installing Automated Train Horns					
	A	B	C	D	E	A+C+E
CROSSING NAME	Estimated Capital Cost	Estimated Annual Maintenance Cost	Capitalized Cost of Annual Maintenance	Estimated Equipment Replacement Cost Every 20 Years	Capitalized Cost of Periodic Equipment Replacement	Total Capitalized Cost
First Street	$100,000	$1,000	$15,000	$66,000	$23,000	$138,000
Second Street	$0					$0
Third Street	$0					$0
Route 23 & 38	$200,000	$2,000	$30,000	$132,000	$46,000	$276,000
Sixth Street	$100,000	$1,000	$15,000	$66,000	$23,000	$138,000
Seventh Street	$100,000	$1,000	$15,000	$66,000	$23,000	$138,000
Tenth Street	$100,000	$1,000	$15,000	$66,000	$23,000	$138,000
TOTALS	$600,000	$6,000	$90,000	$396,000	$138,000	$828,000

The estimated capital cost (Column A) is the initial outlay of funds for engineering, equipment, material, labor including 20% contingencies to install the ATHs. The estimated capitalized cost of the ongoing maintenance (Column C) may be equated to the establishment of a perpetuity fund to pay for the estimated annual maintenance (Column B). Using 7% interest and $1,000 per crossing for annual maintenance, $15,000 would be needed now to establish a maintenance perpetuity (P) fund at each crossing.

Capitalized Cost of Annual Maintenance (P) = $\frac{A}{i}$

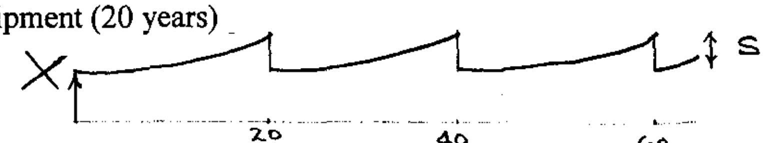
A = Estimated Annual Maintenance Cost ($1,000)
i = Interest rate (7%)



The estimated capitalized cost of the periodic replacement of the ATH equipment (Column E) may be equated to the establishment of a perpetuity fund to pay for the periodic replacement of the ATH equipment (Column D). Based on an estimated equipment replacement cost of $66,000 per crossing with a 20-year life and 7% interest, $23,000 would be needed now to establish a perpetuity fund to pay for the periodic replacement of the ATH equipment at each crossing.

Capitalized Cost of Periodic Equipment Replacement (X) = $\frac{S}{[(1+i)^n]-1}$

S= Estimated cost of equipment replacement ($66,000)
i = Interest rate (7%)
n = estimated life cycle of equipment (20 years)



Conclusion

The investigation determined that Automated Train Horns are the most cost effective safety enhancement option at the 1st Street, Route 23 & 38 intersection, 6th Street, 7th Street and 10th Street grade crossings that will permit the elimination of the locomotive horn. It was also determined that no further improvements are necessary to silence the train horn at the 2nd and 3rd Street grade crossings.

The noise from ATHs impact less than 10% of the area impacted by the noise from a conventional locomotive horn. Automated Train Horns may be safer than conventional horns because they focus the audible alarm right at the motorist. The sound level of the audible alarm in the immediate vicinity of the crossing is higher than the conventional horn located on the locomotive.

The total estimated capitalized cost for the automated train horns is $828,000 and includes the up-front cost for the installations ($600,000), the present value of future maintenance disbursements ($90,000) and the present value of future disbursements for equipment replacement ($138,000).

It is recommended the City of DeKalb meet with representatives from the Union Pacific Railroad, the Illinois Commerce Commission and Illinois Department of Transportation to present the plan and develop a consensus implementation strategy for installation of ATHs at the 1st Street, Route 23 & 38 intersection, 6th Street, 7th Street and 10th Street grade crossings which, in combination with existing full closure gates at 2nd and 3rd Streets, will allow the silencing of the locomotive horn as trains travel through DeKalb.